KOKAI PATENT APPLICATION NO. SHO 60-70603

LIGHTING DEVICE

[Translated from Japanese]

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Translation Requested by: Kari King 3M

Translation Provided by: Yoko and Bob Jasper
Japanese Language Services
16 Oakridge Drive
White Bear Lake, MN 55110

Phone (651) 426-3017 Fax (651) 426-8483
e-mail: jasper.jls@comcast.net

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Lighting Device

[*Shohmei kigu*]

Inventor(s): Rone A. Whitehead
Victoria, British
Columbia, Canada

Applicant(s):	Canadian Patents and Development Ltd. Otawa, Ontario Canada
Agent(s):	Hiroshi Asamura Patent attorney and 2 others

[There are no amendments to this patent.]

[*Translator's Note: Apparently, this document had been previously translated into Japanese from another language; many sentences were unnatural and difficult to understand.*]

Specification

1. Title of the invention

Lighting device

2. Claims of the invention

(1) Lighting device used for optical guide system equipped having a hollow vertical structure with a specific cross-section, a specific area of the walls of a hollow structure made of a dielectric having an inner surface and outer surface that essentially forms //octiture// [phonetic transliteration[1]] and a light-emitting unit that emits light from the hollow structure.

(2) The lighting device described in Claim 1 in which the remaining wall of the hollow structure has a mirror surface.

(3) The lighting device described in Claim 1 or Claim 2 in which the light-emitting unit includes a device capable of changing the angular direction of the light.

(4) The lighting device described in Claim 1 or Claim 2 in which the light-emitting unit includes a rough wall surface.

[1]Translator's note: We could not find a translation for this term.

(5) The lighting device described in Claim 1 or Claim 2 in which the light-emitting unit includes a non-flat wall surface.

(6) The lighting device described in Claim 1 or Claim 2 in which the light-emitting unit includes rounded corners inside the waveform of the wall.

(7) The lighting device described in Claim 1 in which the lighting device further includes a device used for correction of the distribution angle of light inside the hollow structure.

(8) The lighting device described in Claim 7 in which the corrective device includes a diffusion screen.

(9) The lighting device described in Claim 7 in which the corrective device includes a mirror.

(10) The lighting device described in Claim 2 in which a device for correction of the distribution angle of the light is included in the hollow structure of the lighting device.

(11) The lighting device described in Claim 10 in which a diffusion screen is included in the corrective device of the lighting device.

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(12) The lighting device described in Claim 10 in which a mirror is included in the corrective device of the lighting device.

(13) The lighting device described in Claim 1 in which the hollow structure has a rectangular cross-section formed by a four-sided wall, and each wall has an inner surface and an outer surface that forms //octiture//.

(14) The lighting device described in Claim 13 in which the light-emitting unit is arranged on at least one wall surface. (15) The lighting device described in Claim 14 in which many walls are coated with a reflective material to change the direction of light and to return the light through the wall.

(16) The lighting device described in Claim 15 in which the reflective material is a

diffusion material with very high reflectivity.

(17) The lighting device described in Claim 2 in which the hollow structure has a rectangular cross-section formed by a four-sided wall, and each wall has an inner surface and outer surface that forms //octiture//.

(18) The lighting device described in Claim 17 in which the light-emitting unit is arranged on at least one wall surface.

(19) The lighting device described in Claim 18 in which many walls are coated with a reflective material to change the direction of light and to return the light through the wall.

(20) The lighting device described in Claim 19 in which the reflective material is a diffusion material with very high reflectivity.

3. Detailed description of the invention

a. Field of industrial application

The present invention pertains to a lighting device for distribution of light to a certain area, and the invention further pertains to a lighting device used as an optical guide.

b. Prior art

A prism optical guide capable of transmitting light over a great distance is disclosed in detail in US patent No. 4,260,220 issued on April 7, 1981. According to the aforementioned system, lighting of a certain area using a central light such as sun light or another light source is made possible.

c. Problems to be solved by the invention

The purpose of the present invention is to provide a lighting device for optical guide system. The above-mentioned purpose of the present invention can be achieved by a lighting device used for optical guide system equipped with a vertical hollow structure having a specific cross-section, the specific area of the wall of a hollow structure made of a transparent dielectric having an inner surface and outer surface that essentially forms //octiture// [transliteration] and a

light emitting unit that emits light from the hollow structure. The aforementioned lighting device further includes a light-emitting unit for emitting light from the structure. The aforementioned light-emitting unit includes one or more of a non-flat surface, rough surface, rounded corner waveform, irregular wall, and means of controlling lighting angle.

According to a different embodiment, a mirror surface is included for the rest of wall of the hollow structure.

Furthermore, according to a different embodiment, the aforementioned lighting device includes a device for correction of the distribution angle of the light inside the hollow structure. It may include a diffusion screen and/or mirror. The mirror cannot be vertical or flat against the axis of the lighting device.

And furthermore, according to a different embodiment, the hollow structure of the aforementioned lighting device may include rectangular cross-section formed with four walls, and each wall has an inner surface and an outer surface that essentially forms //octiture//. The light-emitting unit is arranged on at least one wall surface. Furthermore, a part of the wall may be coated with a reflective material with very high reflectivity so that all light is reflected by that wall.

Other purposes of the present invention are made clear with a detailed explanation of the drawings.

As explained in detail in United States Patent No. patent No. 4,260,220, the prism optical guide is a vertical hollow structure made of a transparent dielectric, and the wall has a flat inner surface and an outer surface that essentially forms //octiture//.

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The definition of the aforementioned term //octiture// is explained below.

1) The entire inner surface of a certain area, namely, the surface of a certain area of the hollow structure is either vertical or horizontal.

2) The outer surface of a certain area is either vertical or horizontal.

3) And finally, the inner wall makes an angle of 45 degrees with the outer wall. As long as the angle θ of the beam direction of the aforementioned optical guide is below the critical maximum value defined ahead of time and which depends on the refractive index n of the dielectric based on

$$\theta_{max} = \cos^{-1}\{[1-\eta^2\sin^2(22.5°)^{1/2}]/[1-\sin^2(22.5°)]\}$$

the beam is retained inside the structure.

In the case of an acrylic plastic with η=1.5, θ_{max} is 27.6 degrees. Therefore, the prism optical guide emits light having a spatial distribution pre-determined by the size of the guide and the angle of distribution from $-\theta_{max}$ and $+\theta_{max}$.

d. Working examples and effect

A working example of lighting device 10 having the above-mentioned optical guide system is shown in Fig. 1. Lighting device 10 comprises four-sided walls 11 made of a transparent thin dielectric and the inner surface and outer surface form //octiture// inside as in the case of optical guide. Walls 11 are fastened at each corner 12. In this case, a structure having a rectangular cross-section is used, but as long as the inner surface and outer surface form //octiture//, the shape of the cross-section is not especially limited. The first light-emitting unit may be a part of wall 11 itself. As shown in Fig. 2, the light-emitting unit of lighting device 10 has rounded corners 21 that form the outer waveform wall 11. A different light-emitting unit may have non-flat surfaces 31 on the outer waveform wall 11 as shown in Fig. 3. The third light-emitting unit has a rough surface on the wall 11. And furthermore, a different light-emitting unit includes an irregular dielectric inside the wall 11. In the second light-emitting unit, the light-emitting unit is included inside the hollow structure itself, and the refractive element or reflective element inside the hollow structure or near the surface of wall 11 changes the angular direction of the light that exceeds the pre-determined maximum angle of light to be guided, thus, the light is

either refracted or reflected. The light can be emitted from the lighting device 10 under a regulated state based on the above-mentioned hollow structure.

When the light enters one end of the lighting device 10, the light is emitted along the length, and the intensity of light inside the lighting device 10 is reduced according to the length of the lighting device. A graph that shows the intensity of light in the above-mentioned lighting device is shown in Fig. 4. However, in general, constant brightness of light along the length of the lighting device is desired. The brightness of light emitted along the length of lighting device B is a function of the intensity of light I inside the lighting device at the point, angle of light θ and release factor F for reflection, that is B is proportional to IθF. When the light-emitting unit is increased [in size?] along the length of the lighting device, release factor F is increased and as a result, B can be maintained constant along the length of the lighting device. However, it is necessary for the above-mentioned light-emitting unit to change in a complicated shape along the length of the lighting device; thus, aforementioned technology poses a problem.

In the second technology used for achieving a graph of a desired brightness B, the cross-section of the structure is changed to emit the light.

In the third technology used for achieving a graph of a desired brightness B, correction is made for the angle θ of light inside the lighting device. This can be achieved by at least a pair of diffusion screens used inside the lighting device as shown in Fig. 5, or use of a mirror as shown in Fig. 7. In Fig. 5, diffusion screen 51 made of a semi-transparent material is arranged at the center of lighting device 50. Screen 51 provides a rapid change in angle θ of light inside the lighting device and emits the light with high intensity as shown by the graph in Fig. 6.

In Fig. 7, mirror 72 is provided at end member 71 of lighting device 70. In this case, the light reaching end member 71 is reflected, and at the same time, the angle θ is increased.

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Therefore, the brightness is increased at end member 71 compared to the center area of the

lighting device 70 as shown in Fig. 8. When careful selection is made for the degree of increase in angle θ, the same level of brightness can be achieved at both ends of the lighting device 70. Convex mirror 71 is shown in Fig. 7, but an increase in the angle θ can be achieved using a different mirror when the mirror is not perpendicular or horizontal with respect to the axis.

As described above, lighting device 10 forms //octiture//, and one or more walls comprise a dielectric sheet having an inner surface and an outer surface with the light-emitting unit may be included in Fig. 1. The remaining walls are likely to have very high reflectivity based on surfaces having a mirror that absorbs a small quantity of light or based on a prism optical guide having an //octiture// surface. However, when a light-emitting unit having at least one wall surface and/or diffusion screen or mirror inside the lighting device, a small quantity of light is emitted via the prism optical guide wall. In order to prevent the above-mentioned problems, the entire outer wall from which emission of light is not desirable can be coated with a material having very high reflectivity as shown in Fig. 9, and the reflected light that passes the prism optical guide wall of the lighting device returns at high efficiency. A diffusion reflective material is ideal to form the above-mentioned surface. For example, lighting device 90 has three-sided prism optical guide wall 91, and one-sided wall 92 equipped with a light-emitting unit used for emission of light 93. Furthermore, the aforementioned three-sided prism optical guide wall 91 is coated with a diffusion material 94 with very high reflectivity such as mirror, white paint, white plastic, white paper, and white cloth. The aforementioned material 94 reflects light and returns to lighting device 90, and the light passes through desired surface 92 and is emitted.

The above-mentioned working example can be modified within the claims of the present invention, and the claims of the present invention are limited to the attached claims.

4. Brief description of the figures

Fig. 1 is the lighting device of the present invention, Fig. 2 is an example of a light-emitting unit, Fig. 3 is a second example of a light-emitting unit, Fig. 4 is a graph that shows

intensity of light emitted along the lighting device, Fig. 5 is a schematic view of a lighting device equipped with a diffusion screen, Fig. 6 is the graph that shows intensity of light emitted from the lighting device equipped with a diffusion screen, Fig. 7 is a schematic view of a lighting device equipped with a mirror, Fig. 8 is a graph that shows intensity of the light emitted from the lighting device equipped with a mirror, and Fig. 9 is a different working example of a lighting device of the present invention.

Explanation of codes

10: lighting device

11: wall

12: corner

21: rounded corner

31: surface

50: lighting device

51: diffusion screen

70: lighting device

71: end member

72: mirror

90: lighting device

91: wall

92: surface

93: light

94: material

Agent: Hiroshi Asamura, patent attorney

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Fig. 1

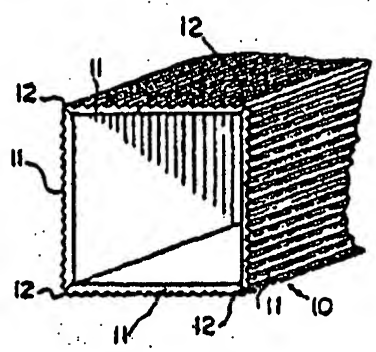

Fig. 2

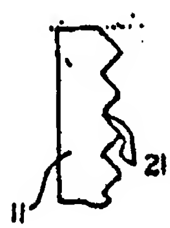

Fig. 3

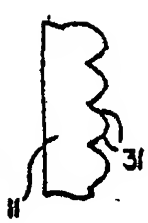

Fig. 4

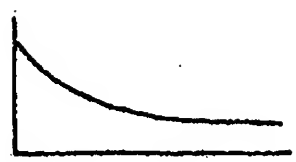

Fig. 5

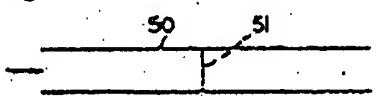

Fig. 7

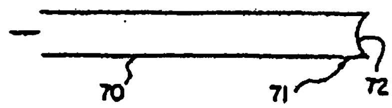

Fig. 6

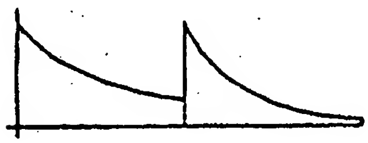

Fig. 8

Fig. 9